AD-A127 123 DMA (DEFENSE MAPPING AGENCY) SOFTWARE IMPROVEMENT PROGRAM TALKING PAPER F..(U) DEFENSE MAPPING AGENCY WASHINGTON DC O R STROUP 12 APR 83 1/1

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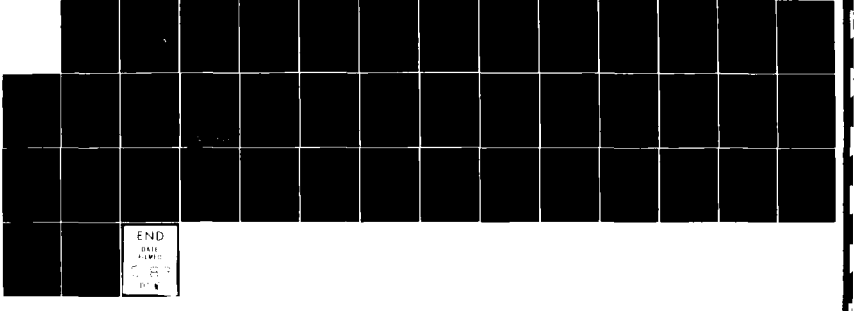

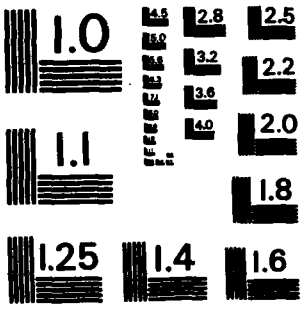

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The Defense Mapping Agency is currently in the initial stages of a five-year program to upgrade a subset of its UNIVAC 1100 Scientific and Technical Software, upgrade manager and software developer skills, and establish an environment to support the software upgrade. The software upgrade will include: translation of non-standard FORTRAN and COBOL to conform to ANSI standards; restructuring; documentation enhancement; and redesign for interactivity. Both in-house and contractual efforts will be used to accomplish this. The software development environment will be modernized with emphasis on standards;

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tools to support the upgrade and software management processes; and tools to improve productivity. Training emphasis includes: software engineering, quality assurance: and productivity assurance. Successful implementation of the SIP will provide the following benefits: a standard software base in which production software is identifiable and maintainable; standard software development practices; tools to improve productivity; and production software which will be less costly and less difficult to convert to different vendor hardware.

DMA SOFTWARE IMPROVEMENT PROGRAM

TALKING PAPER

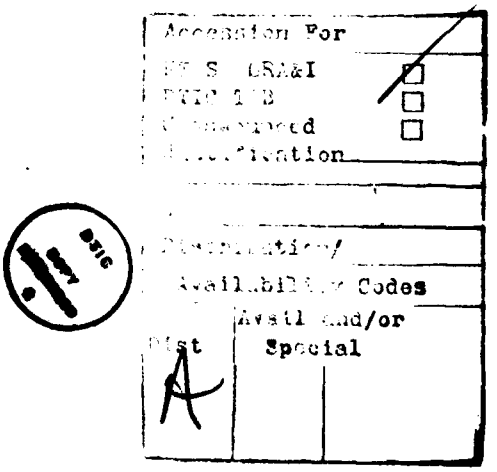
FOR

FEDERAL DP EXPO

(SESSION E-2)

"DEALING WITH OBSOLESCENCE: CONVERSION and UPGRADING

12 APRIL 1983



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DEFENSE MAPPING AGENCY

SOFTWARE IMPROVEMENT PROGRAM

TALKING PAPER

The Defense Mapping Agency (DMA) is currently in the initial stages of a five-year program to upgrade its UNIVAC 1100 Scientific & Technical (S&T) software while modernizing the Agency's software production practices. Ultimate objectives of this Software Improvement Program (SIP) are: increased productivity; improved software quality, maintainability, reliability and portability; and standardization of software development practices. This briefing will provide an overview of the DMA Software Improvement Program. Before describing the Software Improvement Program, it is appropriate to mention DMA's mission, products, and organization.

DMA's mission is to provide Mapping, Charting and Geodetic support and services for the Secretary of Defense, the Joint Chiefs of Staff and military departments, and other DoD Components through the production and worldwide distribution of maps, charts, precise positioning data, and digital data for strategic and tactical military operations and weapons systems. Also, carrying out statutory responsibilities to provide nautical charts and marine navigational data for use by U.S. vessels and navigators in general. (DMA's products and data and major users are illustrated on Viewgraph 3).

DMA has five Components (as illustrated on Viewgraph 4) including two Production Centers (the Aerospace Center (AC) in St. Louis, MO, and the Hydrographic/Topographic Center (HTC) in Brookmont, MD) which produce the MC&G products and data.

Software may be considered a subproduct of the previously illustrated products rather than an end-product in itself. DMA's software is used to produce, maintain, store, and manipulate data, to drive mapping and charting equipment, produce and validate mathematical models, generate data in digital format, and to perform other functions which create DMA products.

The DMA computing environment includes UNIVAC 1100 main frames (as

illustrated in Viewgraph 6). The UNIVAC acquisition history from 1972 to the present as well as the systems which will be in place in 1983 are also illustrated. In 1978, DMA initiated the "Phase II Computer Replacement Program" to competitively acquire computing capacity to support the Agency in the 1982-1990 time frame, by replacing the four UNIVAC 1100s (one 1108 and one 1100/42 per Center). As part of the replacement activity, DMA and the Federal Conversion Support Center (FCSC) performed a software conversion cost analysis (using the FCSC cost model) for each of several acquisition alternatives being considered. To provide the best tradeoff between maximizing competition and avoiding the $30 to $40 million cost of converting DMA's entire applications software inventory to a new target machine, DMA selected the following strategy: upgrade of the UNIVAC CPUs, memory, card equipment and printers; competitive acquisition of tapes and disks, terminals, software redesign; competitive contracts for data base and implementation; local area networking, and technical support services (Viewgraph 7).

In granting the Delegation of Procurement Authority (DPA), GSA suggested that the Agency implement a software improvement program to ensure that DMA will establish an environment which will foster competitive conditions for subsequent procurements. DMA had already recognized a need to improve software and the software development environment and had several on-going related, independent activities in progress. Included in these activities were several Research & Development activities in the area of software development tools.

The Software Improvement Program is intended to consolidate into a single coordinated program many on-going, related activities which have been developing independently. The plan builds on prior Center accomplishments to avoid duplication of effort and to benefit from lessons learned during previous activities. It will initially be implemented for the UNIVAC 1100 systems but will later be extended to the minicomputer as well.

The operational concept for UNIVAC upgrade for the S&T systems calls for transitioning the Agency from a centralized, batch-oriented data processing environment to an interactive processing environment. This includes: acquisition of approximately 500 interactive terminals (HTC - 300, AC - 200); exploitation

of data base management concept and networking; and conversion of non-standard production software to ANS standard languages (ANS FORTRAN X3.9, 1978; ANS COBOL, X3.23, 1974). Transition from the current batch-oriented environment to interactive environment alone is a significant task. This task is complicated by production software deficiencies, lack of required skills, insufficient automated data processing (ADP) staff, and the absence of a modern programming environment. Several recent independent studies have identified serious deficiencies in DMA's production software. These deficiencies may be categorized as follows:

- o Multiple versions of production programs
- o Non-ANS Standard (therefore, nonportable) code
- o Obsolete coding practices resulting in software which is difficult to maintain
- o Logical design which is hardware-dependent and inefficient
- o Poor end-user interface
- o High error-off rate (much of which results from poor user interface)

Most DMA software developers have received formal university training in disciplines other than computer sciences/software engineering (e.g., physical science, mathematics, earth science, cartography, geography, geodesy, photogrammetry, etc.) and few have training/experience in designing interactive software systems. There is insufficient ADP manpower to perform a massive software redesign while simultaneously supporting normal DMA production. Finally, DMA is in only the initial stages of introducing those tools and techniques which constitute a Modern Programming Environment (MPE). Therefore, we have initiated the SIP and directed it at three areas: (1) software upgrade (i.e., software cleanup and software redesign); (2) upgrading of software development personnel skills; and (3) introduction of an MPE into DMA.

Improvement of the existing UNIVAC 1100 S&T software will require three major tasks: (1) inventory of existing software; (2) cleanup of selected existing COBOL and FORTRAN software, and (3) redesign of selected software.

Centers have compiled and continue to refine inventories of existing UNIVAC Scientific and Technical Software. Using such criteria as: the anticipated life of the software; whether and in what time frame the software is to be off-loaded from the UNIVAC 1100; frequency of software use; and criticality of the software to the DMA mission, Centers are identifying candidates for cleanup and/or redesign.

The "cleanup" will consist of five major activities: baseline definition, translation, restructuring, validation, and documentation. Center personnel and/or contractors may accomplish cleanup of software. To the extent possible, cleanup is to be accomplished with automated tools rather than manually. The ultimate goal of the cleanup effort is that all UNIVAC S&T software will be structured, free of vendor extensions, conform to ANS standards, and documented according to DoD standards.

Baseline definition refers to comprehensive testing of software with retention of results for future comparisons.

Translation is defined as the conversion of existing COBOL or FORTRAN code to ANS COBOL X3.23, 1974, or ANS FORTRAN X3.9, 1978 (FORTRAN 77) respectively, with the removal of vendor extensions. The removal of vendor extensions will in no case result in the loss of function. Once the existing UNIVAC 1100 software has been converted to the ANS standard, future conversions to a non-UNIVAC mainframe or conversion to the ANS subset for minicomputer systems will be more easily accomplished. Translation to ANS Standard will result in portable, non-vendor-dependent code. DMA does not have a translator tool to accomplish this task. Manual translation would be extremely labor-intensive and error prone. Therefore, DMA plans to require "software redesign/ cleanup contractors" to provide such a tool.

Restructuring is the changing of nonstructured code to structured code (i.e., code containing only the following logic structures: Sequence Block,

IF-THEN-ELSE, DO UNTIL, DO WHILE, CASE). Restructuring reveals the structure of an algorithm so that its existing code may be maintained, modified, or documented. The restructuring process does not change program logic, and it does not redesign "spaghetti." However, the structured code generated by the structurizer is more readable than the original code and, therefore, is more maintainable.

DMA owns a FORTRAN Automated Verification System (FAVS) which provides a FORTRAN structurizer as one of its major subsystems. FAVS is currently being made ready for production use via a maintenance contract with the tool developer, General Research Corporation (GRC). Similarily, a COBOL Automated Verification System (CAVS) is being developed for DMA. A restructuring capability for COBOL is an option which DMA may exercise.

The validation task refers to the duplication of baseline testing for cleaned up software to ensure that the process did not introduce errors.

The software documentation task consists of both automatic and manual generation of documentation.

During software cleanup, missing or inadequate documentation will be augmented with both automatically and manually generated materials. Automatic generation of reports about code such as static analysis (ANS standard violations, flow analysis errors, portability and flow metrics); complete layout of all files; detailed cross-reference of all statements; and a map of data usage in the COBOL procedure division will be produced as software is cleaned up/redesigned. The purpose of the reports is to assist maintenance programmers in reading and analyzing code and in controlling the impact of program modification.

The FAVS will provide the following documentation for FORTRAN code: invocation summary, common matrices, input/output statements, and cross-reference of external variables for multiple modules; and symbol reports, cross-reference reports, invocation space reports, and invocation bands reports for individual modules. CAVS (when available) will generate the

following reports: an indented listing of COBOL source; cross-reference of calling and called programs; cross-reference of program and file interaction; cross-references of program and copy text instruction showing where copy texts are used; cross-reference of program versus linkage section contents; reports showing where all identifiers are defined, set, and used; and a cross-reference of identifiers by record position and programs, showing fields defined, set and used, and when and where identifier names differ.

During the inventory phases, Centers identified documentation available for application programs. Missing user documentation is to be written ("manually") during the redesign effort. In cases where contractors perform software redesign, the contractor will prepare such missing documents. In cases where required improvement includes "only" enhancing/preparing documentation, in-house effort will be used.

To allow the Centers to solve a variety of software problems, redesign is broadly defined as any appropriate combination of the following:

- o Rewrite all or portions of the code for interactivity.
- o Redesign of the user interface (leave the code untouched while creating a new "front end" to improve user interface).
- o Optimization of those portions of code which consume the greatest resources (based on results of instrumentation and use of metrics).
- o Rewrite portions of the code to increase reliability.
- o "Scrap" the existing program and rewrite the algorithm using the "structured code" as a basis for understanding.

The DMA approach to the software improvement effort is to contract for the redesign/cleanup of selected software. DMA intends to award Basic Ordering Agreements (BOAs) to all contractors possessing certain corporate experience, personnel experience, and software tool access/experience. An RFP was issued

in 1982 for Software Redesign/cleanup and proposal evaluation is in progress. On a case-by-case basis, DMA will issue delivery orders describing the desired redesign. A firm fixed-price contract will be awarded for each delivery order on the basis of technical approach and cost. The contractor may be tasked with cleanup only or cleanup plus desired redesign activities. The contractor is being required to use automated tools to translate code to ANSI, and restructure it, etc. New code is to be rewritten using only structured programming constructs. In some cases, the contractor will redesign software that has been cleaned-up in-house. In others, unstructured, untranslated code will be the contractor's input--especially during the early stages of the effort. Since DMA is concurrently attempting to introduce several tools into the software development environment, (e.g., FORTRAN precompiler), contractors will be required to interface with them. For example, a contractor writing structured FORTRAN would be required to use those constructs and delimiters acceptable to the DMATRAN precompiler.

The improvement (cleanup and redesign) of DMA software will consume a significant amount of resources over a period of five years. To ensure maximum return from this investment, DMA must take actions to ensure that modification/maintenance of the improved software does not result in the introduction of the deficiencies discussed above. Moreover, all new software developed must be of the same (or higher) quality as the improved software. Therefore, DMA is concurrently introducing a UNIVAC 1100 Modern Programming Environment (MPE). The MPE will include a centralized Production Program Library which will be the repository for production programs and documentation (in human and machine readable form). As each software system is cleaned up and/or redesigned, it will be migrated into the production program library at the appropriate Center and will be placed under control of the newly formed Configuration Control Board (CCB).

Tools to support an MPE implementation plan may be grouped into three general categories: (1) conversion aids for existing software, (2) management aids for existing software, and (3) productivity assistance tools for FORTRAN. Three categories of conversion aids are considered in this plan: static analyzers, precompilers, and structuring engines. The FORTRAN Automated

Verification System (FAVS) provides each of these tools. FAVS deficiencies are currently being corrected so that the tool can be introduced for production use. Similiarly, the CAVS will be made available for production use once it is production-ready. A COBOL precompiler which will interface with CAVS is also available. The term precompiler is used here to refer to a tool which simplifies the task of writing structured code in such language as FORTRAN and COBOL which do not support all of the structured figures.

Two classes of tools to manage existing software (whether developed in-house or by contractors) are being considered by DMA.

The first class of such tools is the code auditor to automatically check for adherence to Center standards for structuring and ANS Standards. Use of such a tool would allow DMA to avoid the more labor-intensive, and error-prone manual methods. However, acquisition of a tool is not anticipated prior to introduction of standards.

The second class of tools being considered are configuration control tools which automatically track changes to software and permit only authorized changes to an official version of software. DMA plans to investigate acquisition of such a tool to support the CCB activities. In the interim a manual system is being implemented.

DMA has a great deal of batch-oriented software which requires some form of interactivity. Two approaches can be taken when introducing interactivity. A separate user interface can be written for each individual program. A second approach is to provide a dialog manager capability to interface with the operating system rather than using COBOL and FORTRAN to do this interface. DMA plans the second approach and has acquired the SPERRY UNIVAC Display Processing System (DPS 1100) which separates the development and use of predefined screens from the applications program itself. Center personnel are currently learning to use this tool.

The third major phase of implementing DMA's UNIVAC 1100 MPE is the

introduction of Standards (which apply to all mainframe and minicomputer software development) into the Centers.

DMA has issued a four-volume set, "DMA Software Life Cycle Standards," which is tutorial in nature, takes into consideration Center differences, conforms to DoD ADS standards (DoD 7935.1-S) and reflects state-of-the-art ADP software practices. It consists of: DMA Software Design and Implementation Standards Manual (SDISM); Structured Programming in FORTRAN; Structured Programming in COBOL; and Structured Walk-Through Guidelines. Volumes II and III detail the simulation of basic structured programming constructs and, thus, allow generation of "structured code" without the use of precompilers. Volume IV provides general guidelines for structured walk-throughs for all software life cycle phases. Following Center review, the standards will be introduced in a phased manner. An additional document, Software Contracting Guidelines is being developed to assist non-ADP personnel in contracting for software.

The third major area addressed by the SIP is the upgrading of the skills of both managers and software developers. Areas of emphasis for managers are: quality assurance, managing structured programming projects, project management and control, state-of-the-art awareness, productivity assurance, and contracting for software. Managers must understand the concepts and methods employed in an MPE since they differ from those of the traditional software projects.

Four areas of training will be emphasized for software developers: (1) UNIVAC skills, (2) state-of-the-art awareness, (3) MPE introduction, and (4) new technology. As with management training, a variety of methods (e.g., lectures, seminars, laboratory, video cassette, on-site) will be used. Training topics include: the structured software life cycle; applying standards; use of tools (e.g., FAVS, DMATRAN); designing interactive systems; using terminals; UNIVAC refreshers; data base maintenance; query language/report generators; structured life cycle standards; redesigning existing software; and optimization techniques, networking, communications and graphics.

In summary, DMA is committed to a five-year Software Improvement Program plan encompassing three major areas: introduction of a modern programming

environment, improvement of existing software, and upgrading development and management skills to support the new environment. General policy includes: adoption/use of structured programming as a standard, maximizing the use of tools to facilitate software development, compliance with ANS COBOL and FORTRAN standards, establishment/use of a centralized program library, adoption/enforcement of software life cycle standards, elimination of multiple versions of common software, establishment of quality assurance groups to ensure adherence to standards, introduction of a Configuration Control Board, introduction of interactivity, and a phased approach to software cleanup/redesign in which high priority software is cleaned up/redesigned first.

Successful implementation will provide the following benefits:

- o A competitive environment in which DMA will not be locked into a single hardware vendor because of the difficulty/costliness of software conversion.

- o A standard software base in which production software is identifiable and maintainable.

- o Standard software development practices within and between Centers.

- o Tools to improve productivity.

- o A modern environment offering increased job satisfaction to software developers.

DEFENSE MAPPING AGENCY (DMA)

SOFTWARE IMPROVEMENT PROGRAM

OBJECTIVE

- TO PRESENT AN OVERVIEW OF THE DMA SOFTWARE IMPROVEMENT PROGRAM

Major Users of DMA MC&G Products and Data

	Precise Positions	Maps/Charts	Digitized Map (Terrain)	Information (Culture)	Gravity and Geophysical Data	Electronic Navigational Aides
WARSHIPS						
Aircraft Carriers	●	●			●	●
Submarine Systems	●	●			●	●
Other surface ships and submarines		●				●
AIRCRAFT						
AWACS (Airborne Warning and Control System)		●	●			
SAC: B-52, FB-111, KC-135	●	●	●	●		
TAC: F-15, F-16, A-7, A-10	●	●	●	●		
MAC: C-130, C-141, C-5A	●	●	●	●	●	
Navy/Marine Corps:						
Attack: A-4, A-6, A-7	●	●	●	●		
Fighter: F-14, F-18	●	●	●	●		
Patrol: P-3	●	●	●	●		
LAND FORCES						
Infantry/Mechanized Units		●				
Tanks		●				
Attack Helicopters		●				
Artillery (supported by Firefinder System)	●	●	●			
MISSILES						
Minuteman, MK	●	●			●	
Pershing II	●	●	●	●		
SRAM (Short Range Attack Missile	●	●				
Cruise Missiles	●		●	●		
Poseidon/Trident	●				●	
MERCHANT MARINE						
U.S. Flag Vessels		●				●
Foreign Flag Vessels		●				●
Private Yachts		●				●

DEFENSE
MAPPING
AGENCY

HEADQUARTERS, WASHINGTON, D.C.

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AEROSPACE CENTER	HYDROGRAPHIC/ TOPOGRAPHIC CENTER	OFFICE OF DISTRIBUTION SERVICE	DEFENSE MAPPING SCHOOL	INTER AMERICAN GEODETIC SURVEY
ST. LOUIS, MO.	BROOKMONT, MD.	BROOKMONT, MD.	FT. BELVOIR, VA	FT. SAM HOUSTON, TX

SIP OBJECTIVES

- PROVIDE STANDARD SOFTWARE BASE
- INTRODUCE STANDARD PRACTICES
- IMPROVE PRODUCTIVITY
- ESTABLISH COMPETITIVE ENVIRONMENT

UNIVAC ACQUISITION HISTORY

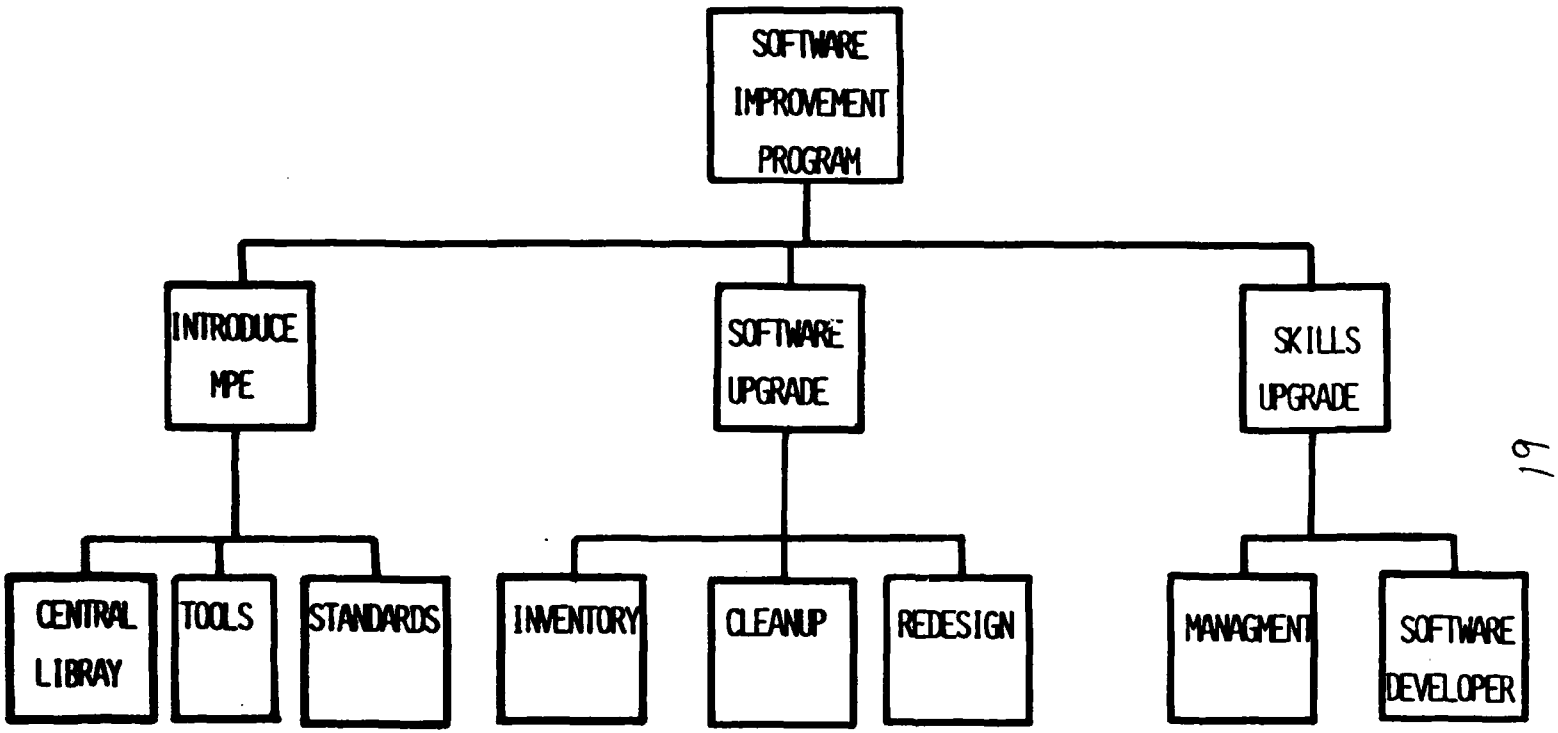
	1972	1977	1980	1983
AC	UNIVAC 1108	UNIVAC 1108 UNIVAC 1100/42	UNIVAC 1100/81 UNIVAC 1100/82	UNIVAC 1100/82 2x1 UNIVAC 1100/84 4x4 UNIVAC 1100/82 2x1 UNIVAC 1100/62 2x2
HTC	UNIVAC 1108	UNIVAC 1108 UNIVAC 1100/42	UNIVAC 1100/81 UNIVAC 1100/81	UNIVAC 1100/82 2x1 UNIVAC 1100/82 1x1 UNIVAC 1100/62 MP 2x1 UNIVAC 1100/61 1x1

PHASE II COMPUTER ACQUISITION PROGRAM

1. S&T CONTRACTS
   - UNIVAC CPU's, MEMORY, CARD EQUIP., & PRINTERS
   - TAPE & DISK
   - TERMINALS
   - SOFTWARE REDESIGN
2. DATA BASE CONTRACTS
   - REQUIREMENTS ANALYSIS
   - CONCEPTUAL DESIGN
   - IMPLEMENTATION
3. LOCAL AREA NETWORK CONTRACT
4. TECHNICAL SUPPORT SERVICES CONTRACT

BACKGROUND

- JULY 1981 - DPA FOR PHASE II FROM GSA
- SUGGESTED SOFTWARE IMPROVEMENT PLAN
- ATTEMPT TO CONSOLIDATE MULTI-PROGRAMS
- SIP - S&T SOFTWARE FOR UNIVAC 1100 INITIALLY


SOFTWARE IMPROVEMENT PROGRAM
INTRODUCE MPE
SOFTWARE UPGRADE
SKILLS UPGRADE
CENTRAL LIBRAY
TOOLS
STANDARDS
INVENTORY
CLEANUP
REDESIGN
MANAGMENT
SOFTWARE DEVELOPER

SOFTWARE IMPROVEMENT PLAN

- SOFTWARE IMPROVEMENT
- INTRODUCE MODERN PROGRAMMING ENVIRONMENT (MPE)
- UPGRADE SKILLS

SOFTWARE IMPROVEMENT

- INVENTORY
- CLEAN-UP
- REDESIGN

INVENTORY

- GROUP PROGRAMS
- CATEGORIZE
- ASSIGN PRIORITIES

CLEAN-UP

- BASELINE TESTS
- TRANSLATE - ANSI
- STRUCTURE
- DOCUMENT - DoD 7935.1-S
- DEMONSTRATE & SYSTEM TEST
- PUT UNDER CONFIGURATION CONTROL

REDESIGN

- CLEAN-UP ONLY

OR

- CLEAN-UP PLUS REDESIGN FOR
  - INTERACTIVITY
  - IMPROVED USER INTERFACE
  - OPTIMIZATION
  - RELIABILITY
  - MAINTAINABILITY

APPROACH

- CONTRACTOR - BOA
- IN-HOUSE

INTRODUCE MPE

- CENTRALIZED LIBRARY
- TOOLS
- STANDARDS

CENTRALIZED LIBRARY

- SINGLE REPOSITORY TO STORE & MAINTAIN CODE
  - ENHANCE VISIBILITY
  - PRODUCE SINGLE VERSION OF COMMON SOFTWARE
- EVOLUTIONARY APPROACH
- STATUS

TOOLS

- CONVERSION AIDS FOR EXISTING SOFTWARE
  - STATIC ANALYZERS
  - PRECOMPILERS
  - STRUCTURING ENGINES
- MANAGEMENT OF EXISTING SOFTWARE
  - CODE AUDITORS
  - CONFIGURATION CONTROL
- PRODUCTIVITY ASSISTANCE
  - TERMINAL INTERFACE

STATIC ANALYZERS

- **FAVS**
  - FORTRAN AUTOMATED VERIFICATION SYSTEM (FAVS)
  - GENERAL RESEARCH CORPORATION (GRC)
  - DEVELOPED VIA RDT&E
  - PRODUCTION ENVIRONMENT
- **CAVS**
  - COBOL AUTOMATED VERIFICATION SYSTEM (CAVS)
  - BEING DEVELOPED UNDER RDT&E
  - FY 83 DELIVERY
  - INTERACTIVE

PRECOMPILERS

- FORTRAN PRECOMPILER (DMATRAN)
  - GENERAL RESEARCH CORPORATION
  - FAVS
  - PRODUCTION ENVIRONMENT
- COBOL STANDALONE PRECOMPILER
  - IBM
  - CAVS INTERFACE

STRUCTURING ENGINES

- FAVS
  - GENERAL RESEARCH CORPORATION
  - PRODUCTION ENVIRONMENT
- CAVS
  - GENERAL RESEARCH CORPORATION
  - OPTION FOR STRUCTURIZER

CODE AUDITORS

- ENFORCE STANDARDS
  - STRUCTURE
  - ANSI
- AUTOMATE STANDARDS ENFORCEMENT
- INVESTIGATE OFF-THE-SHELF TOOLS

CONFIGURATION CONTROL

- AUTOMATIC TRACKING & AUTHORIZATION FOR SOFTWARE CHANGES
  - TRACK CHANGES TO PRODUCTON SOFTWARE DURING CLEANUP & MAINTENANCE
  - MAKE ONLY AUTHORIZED CHANGES TO PRODUCTION PROGRAMS
- INVESTIGATE OFF-THE-SHELF TOOLS
- COORDINATE WITH CONFIGURATION MANAGEMENT

TERMINAL INTERFACE

- ELIMINATE CODING
- DIALOG MANAGER CAPABILITY
- DPS 1100 - PHASE II COMPUTER ACQUISITION

DMA SOFTWARE LIFE CYCLE STANDARDS

- FOUR VOLUMES
- BASED ON STRUCTURED PROGRAMMING SERIES
- COMPATIBLE WITH INDUSTRY STANDARDS
- APPLICABLE TO MAINFRAME AND MINIS
- COMPONENT REVIEW

SKILLS UPGRADE

- MANAGERS
- SOFTWARE DEVELOPERS

MANAGERS

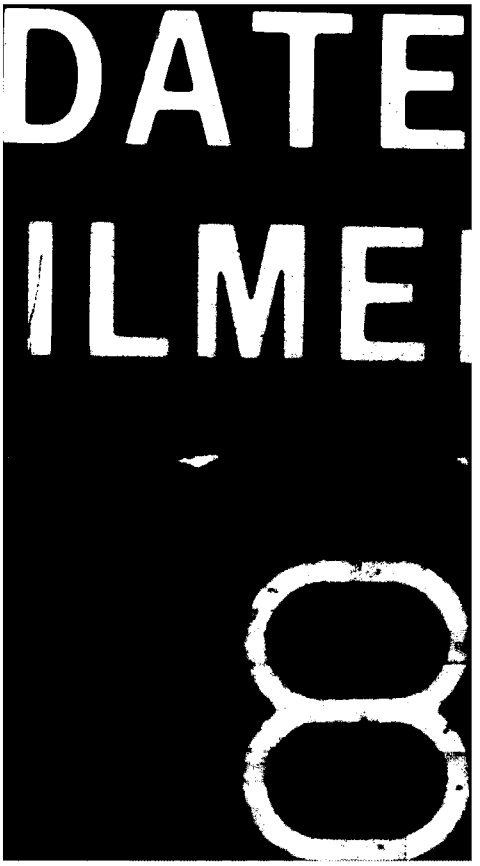
- AREAS OF EMPHASIS
  - QUALITY ASSURANCE
  - MANAGING STRUCTURED PROGRAMMING PROJECTS
  - PROJECT MANAGEMENT & CONTROL
  - SOTA AWARENESS
  - PRODUCTIVITY ASSURANCE
- LECTURE SERIES; VENDOR; ON-SITE

SOFTWARE DEVELOPERS

- FOUR AREAS OF EMPHASIS
  - UNIVAC SKILLS
  - SOTA AWARENESS
  - MPE INTRODUCTION (SOFTWARE ENGINEERING)
  - NEW TECHNOLOGY
    - DATA BASES
    - NETWORKING
    - COMMUNICATIONS
    - GRAPHICS
    - DESIGNING INTERACTIVE SYSTEMS
- LECTURE SERIES; UNIVERSITY; VENDOR; VIDEO-CASSETTE; SELF-TAUGHT; IN-HOUSE

SUMMARY

- BENEFITS
  - COMPETITIVE ENVIRONMENT
  - STANDARD SOFTWARE BASE
  - STANDARD PRACTICES
  - TOOLS TO IMPROVE PRODUCTIVITY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